PAN-PACIFIC ENTOMOLOGIST
64(3), 1988, pp. 228–242

Descriptions of the Immatures of *Typocerus serraticornis* (Coleoptera: Cerambycidae), and New Observations on Biology, Including "Varnish" Production and Usage by the Larva

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Abstract.—The larva, pupa and egg of *Typocerus serraticornis* are described. Observations on the host plant *Oryzopsis hymenoides,* mating, oviposition, larval feeding and pupal cell construction follows. Parasitization of the larva by a Dipteran maggot *Arctophyto borealis* and the production and usage of "varnish" by the larva are also discussed.

Introduction

Typocerus serraticornis Linsley and Chemsak, 1976, was described from 27 specimens collected over a period of 35 years in the Great Basin and on the western slope of the Rocky Mountains. In the description the authors mentioned one male and two females having emerged from *Oryzopsis hymenoides* (Roem. and Schult.) Ricker. These three specimens had been sent to John Chemsak by L. Guerra S., a person working at the Desert Experimental Range, 27 miles west of Milford, Utah, [with no further contact being made (Chemsak, pers. comm.)]. In 1979 R. L. Penrose recorded the collection of *T. serraticornis* by himself and R. L. Westcott in southeastern Oregon on flowers of *Sphaeralcea grossulariaefolia* growing intermixed with *O. hymenoides* (for which the common name "Sand dropseed" was used in error; Westcott, pers. comm.). Additionally he mentions collecting the beetles at a point 22 mi NW (sic, should be "W," according to R. L. Westcott, in litt.) of Denio Junction, Humboldt Co. Nevada, with beetles abundant, having been on an "area of sand, covered almost exclusively with *O. hymenoides*. They were observed flying slowly about, and sitting and mating on this grass. Occasionally, females were noted crawling on the surface of the sand around the plant in search of oviposition sites. Larvae were found at both localities boring in the culm bases, below the soil surface, indicating at least a two-year life cycle."

Being fortunate in finding specimens of *T. serraticornis* in the field myself, I can now relate the association between plant and insect and other biological features. On June 13, 1985 L. Ford and I collected and made biological observations on the species at Larkin Dry Lake in Mono Co., California and 0.7 mi E of Larkin Dry Lake in Mineral Co., Nevada. During June 13–21 and December 27–30 of 1986 we collected at the two sites again plus 3 others: Green Springs, 7 mi E of Gabbs, Nye Co. and the SE shoreline of Smith Creek Dry Lake in Lander Co., Nevada; Tinemaha Creek, Inyo Co. California, and in Mono Co. California, 11 mi W of the state line, on Highway 167. In the first week in June, 1987, we returned for additional field work, but because of overgrazing, the host plant at this last site was temporarily lost and we chose a new site 4.5 mi W of the state line also on Highway 167. Conditions at the Larkin Dry Lake site were normal and beetles were present. The occurrence of this species at three of the California sites are new records for the state.

Descriptions of the Early Stages

Mature larva.—Larvae were found at four sites, Larkin Dry Lake and its proximity, the sites 11 mi and 4.5 mi W of the state line, and at the Smith Creek Dry Lake site. This description is based on three living larvae varying in length from 13.8 mm (9/16 in) to 17.3 mm (11/16 in), one from each site, and 4 larval skins from Larkin Dry Lake.

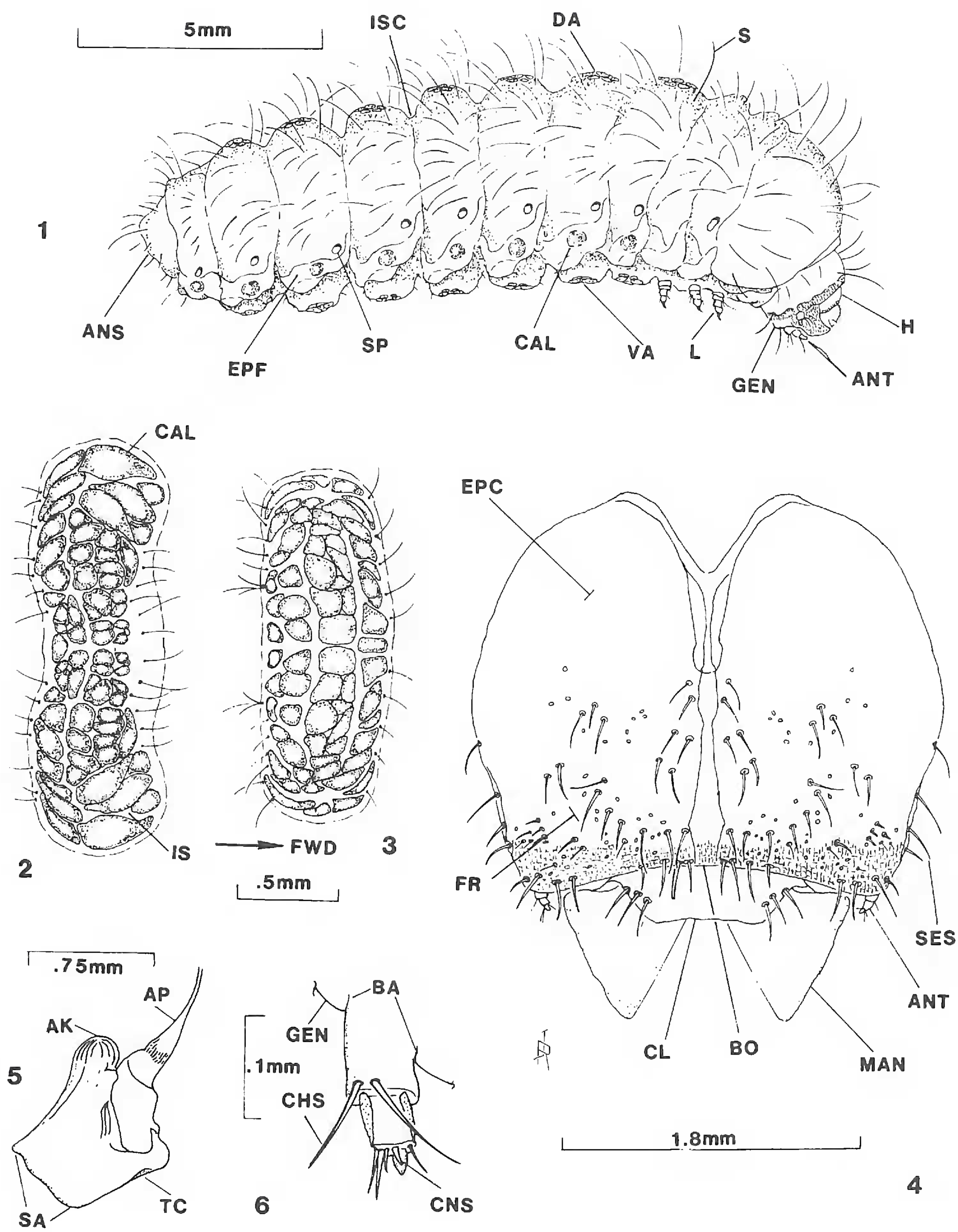
General. Usual cerambycid form, fleshy, elongate, nearly circular in cross-section, sub-cylindrical, tapering, widest just behind the head, somewhat compressed laterally. Living larva saffron-yellow (probably carotenoids from the host plant), the color concentrated in the adipose tissue. Integument transparent, shining, pale ivory in color. Prothorax unicolorous. Intersegmental constrictions deep, well defined. Lateral epipleural folds pronounced, a single large callosity on each fold. Eight pairs of spiracles on abdominal segments I–VIII and one pair on mesothorax; spiracles lightly pigmented, measurements (through vertical axis) abdominal .08 to .1 mm, thoracic .12 mm. Larval dorsum and venter somewhat wrinkled. Dorsum sparsely clothed with erect copper-colored setae, these somewhat more dense on sides, almost absent ventrally. Anal segment 3-lobed, unmodified and without plates or special modifications (Fig. 1). Asperites absent. Transverse ampullae on ventral side, from mesothorax to seventh abdominal segment, each consisting of two indistinct rows of callosities; and on the dorsal side of abdominal segments I–VII, each with three distinct rows; interstices depressed, sparse sensilla on periphery only (Fig. 2–3).

Head. Sub-orbicular, 2.9 mm wide, 2.6 mm long, top of epicranium to bottom of clypeus, sclerotized, mostly unpigmented, frons to buccal opening clothed with semi-erect setiform sensilla. Clypeus, buccal opening and mandibles medium to dark reddish brown, antennae and palpi pale to medium reddish brown. In frontal view, buccal opening oblong, antennal sockets above mid-line on genae. Labium and labrum ivory to pale reddish brown, lower lateral margins dark reddish brown. Stemmata absent. (Fig. 4 and Fig. 25).

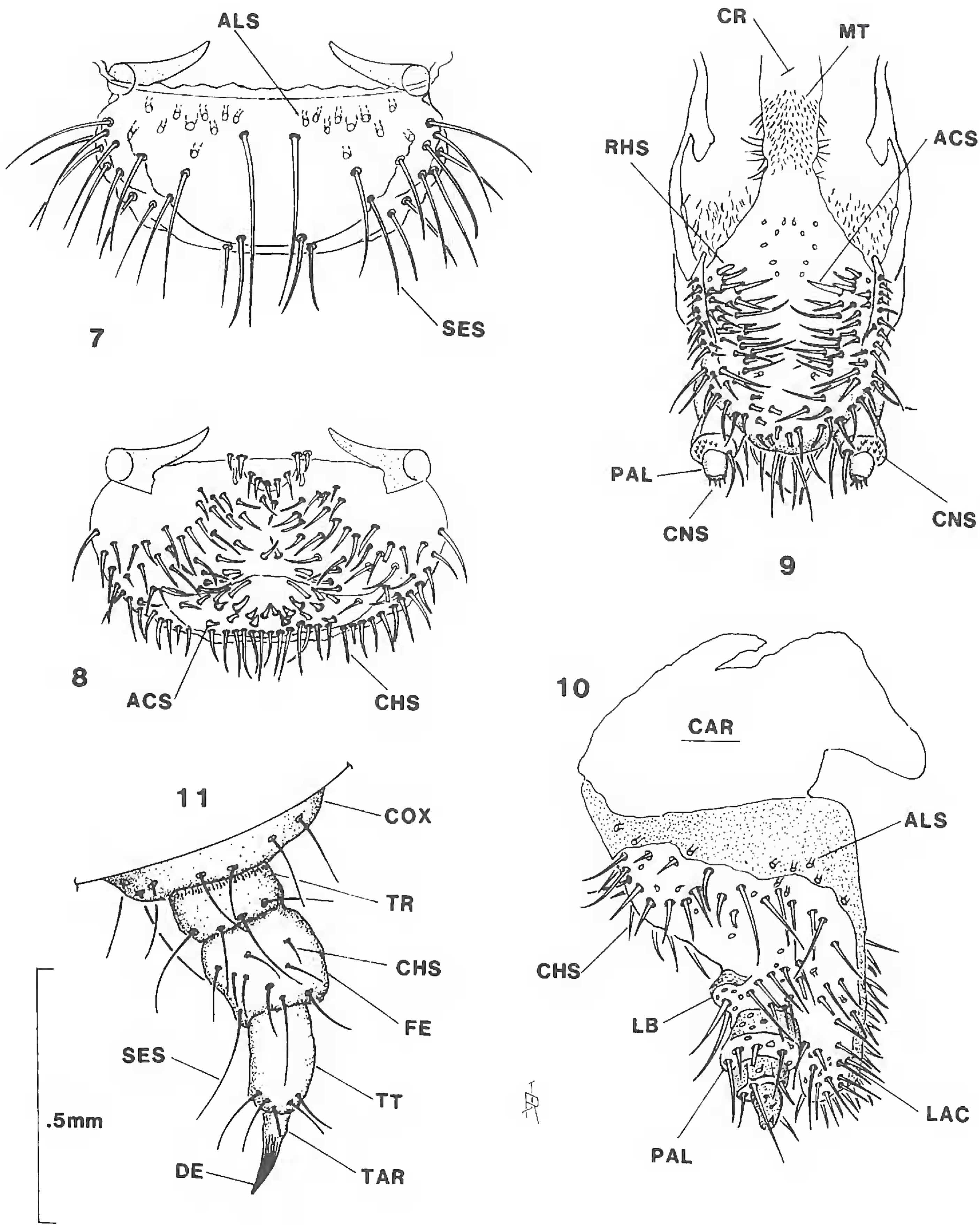
Mandible. Short, thick-prismatic in shape, concave on inner surface, with transverse cleft on side near labrum, anterior and posterior articular knobs prominent, apodeme broadly attached (Fig. 5 and Fig. 26). (Extremely hard, as shown by "flaking.")

Antenna. Retractile, moving in and out of socket in living larva. Short, 3-segmented, segments cylindrical, abruptly narrower distally (stepped or "castled"), 2nd segment two-thirds diameter of first, third tapered, one-third diameter of second, steps with chaetiform sensilla, outer end with one large coniform and numerous setiform sensilla (Fig. 6 and Fig. 27).

Labrum. Semi-circular, half as long as wide, outer surface with scattered setiform sensilla, these more dense along the circular margin, upper portion with generally small and oval alveoliform sensilla, two conspicuously larger and circular; inner surface densely covered with chaetiform sensilla along the circular margin and semi-erect acutiform sensilla arranged radially with apices pointing toward the middle (Fig. 7–8 and 28).



Figures 1–6. *Typocerus serraticornis,* larva. Figure 1. Larva, lateral view. ANS, anal segment; ANT, antenna; CAL, callosity; DA, dorsal ampullae; EPF, epipleural fold; GEN, gena; H, head; ISC, intersegmental constriction; L, leg; S, seta; SP, spiracle; VA, ventral ampullae. Figure 2. Ventral ampullae. CAL, callosity; IS, interstices. Figure 3. Dorsal ampullae. 4. Head, anterior view (labrum removed). ANT, antenna; BO, anterior margin of buccal opening; CL, clypeus; EPC, epicranium; FR, frons; MAN, mandible; SES, setiform sensilla. Figure 5. Mandible, left, inner view. AK, articular knob; AP, apodeme; SA, scissorial area; TC, transverse cleft. Figure 6. Antenna. BA, basal articulation; CHS, chaetiform sensilla; CNS, coniform sensilla; GEN, gena of head capsule.



Figures 7–11. *T. serraticornis* larval structures. All figures to the same scale. Figure 7. Labrum, anterior view. ALS, alveoliform sensilla; SES, setiform sensilla. Figure 8. Labrum, posterior view. ACS, acutiform sensilla; CHS, chaetiform sensilla. Figure 9. Labium, anterior view. ACS, acutiform sensilla; CNS, coniform sensilla; CR, central ridge; MT, microtrichia; PAL, palpi; RHS, rhabdiform sensilla. Figure 10. Maxilla, right, anterior view. ALS, alveoliform sensilla; CAR, cardo; CHS, chaetiform sensilla; LAC, lacinia; LB, lateral boss; PAL, palpus. Figure 11. Thoracic leg, left, anterior view. CHS, chaetiform sensilla; COX, coxa; DE, distal end; FE, femur; SES, setiform sensilla; TAR, tarsus; TR, trochanter; TT, tibiotarsus.

Labium. Linguiform, margins with chaetiform sensilla, acutiform, rhabdiform and digitiform sensilla arranged radially with apices pointing toward the middle. A patch of micro-trichia present on the central ridge (Fig. 9 and Fig. 28).

Palpus. Short, 2-segmented, segments cylindrical, abruptly narrower distally (stepped or "castled"), first segment two times diameter of second, with many coniform and several chaetiform sensilla on step, and numerous coniform sensilla on outer end of second segment (Fig. 9 and Fig. 29).

Maxilla. broadly triangular, angled slightly outward, forming a protruding lateral boss bearing the palpus; upper and inner portions pigmented, upper portion with digitiform sensilla, chaetiform sensilla present on the rest of surface including boss (Fig. 10 and Fig. 29).

Palpus. Three segmented, segments cylindrical, abruptly narrower distally (stepped or "castled"), truncated conical, second segment two-thirds diameter of first, third segment bluntly tapered, one-half diameter of second, more darkly pigmented, slightly longer than lacinia, with digitiform and chaetiform sensilla (Fig. 10).

Labrum, labium, maxilla and palpi tumid in living larva (Fig. 29).

Legs. All three pairs equal, .87 mm long, (coxa .1, trochanter .15, femur .3, tibiotarsus .17, tarsus .15); coxa dome-shaped, trochanter, femur, tibiotarsus all cylindrical, tarsus acutely tapered, distal end sclerotized, pigmented. All segments bearing chaetiform and setiform sensilla (Fig. 11).

Pupa. Pupal development begins in early May in the field. In grass samples collected at the sites in June and December 1986, placed in sand in screened cages for further observation at my home (Fig. 14), pupae began developing during late March and early April 1987. This description is of a live male pupa.

General. Typical exarate cerambycid pupa; pupal sac loosely bound, abdomen gyrates when pupa disturbed. Caudal margins of abdominal tergites bearing spines, in sub-medial groups on segments one through seven, a complete series across segments eight and nine; mesothorax with sub-medial patches. Each femur with a row of transverse spines on apex. Each tarsus with a single lateral spine on terminal segment. Antenniferous callosities and frons spined, spines sparse on prothorax. Head with a small carina on posterior margin (lacking in adult). Although adult beetles "squeak," the mesothoracic stridulatory ridge appears lacking (Fig. 12). Saffron-yellow color of larva carries over into pupa. Pupa initially un-pigmented except for eyes, pigmentation commencing in tarsi on tenth day; on legs, head and thorax on twelfth day, on abdomen on fourteenth day. Pupa moults at the end of the third week.

Egg. Based on eggs removed from a virgin gravid female preserved in 75% ethanol. Size.—3.12 mm × 1.03 mm. Shape.—Elongate fusiform (Fig. 30a). Ridges of chorion forming polygons (Fig. 30b). Color.—Whitish.

Given the female's swollen size (Fig. 16), I thought the number of eggs would be considerable. However, only 33 eggs were found. Her swollen body was the result of large egg size.

By comparison to other cerambycids, the egg is unusually large for this small lepturine. Many species of this and larger size have greater numbers of noticeably smaller eggs (Chemsak and Linsley, 1971:154; Leech, 1963:187; Hess, 1920:372, 377). The eggs are tightly packed linearly into the abdominal cavity, extending into the mesothorax.

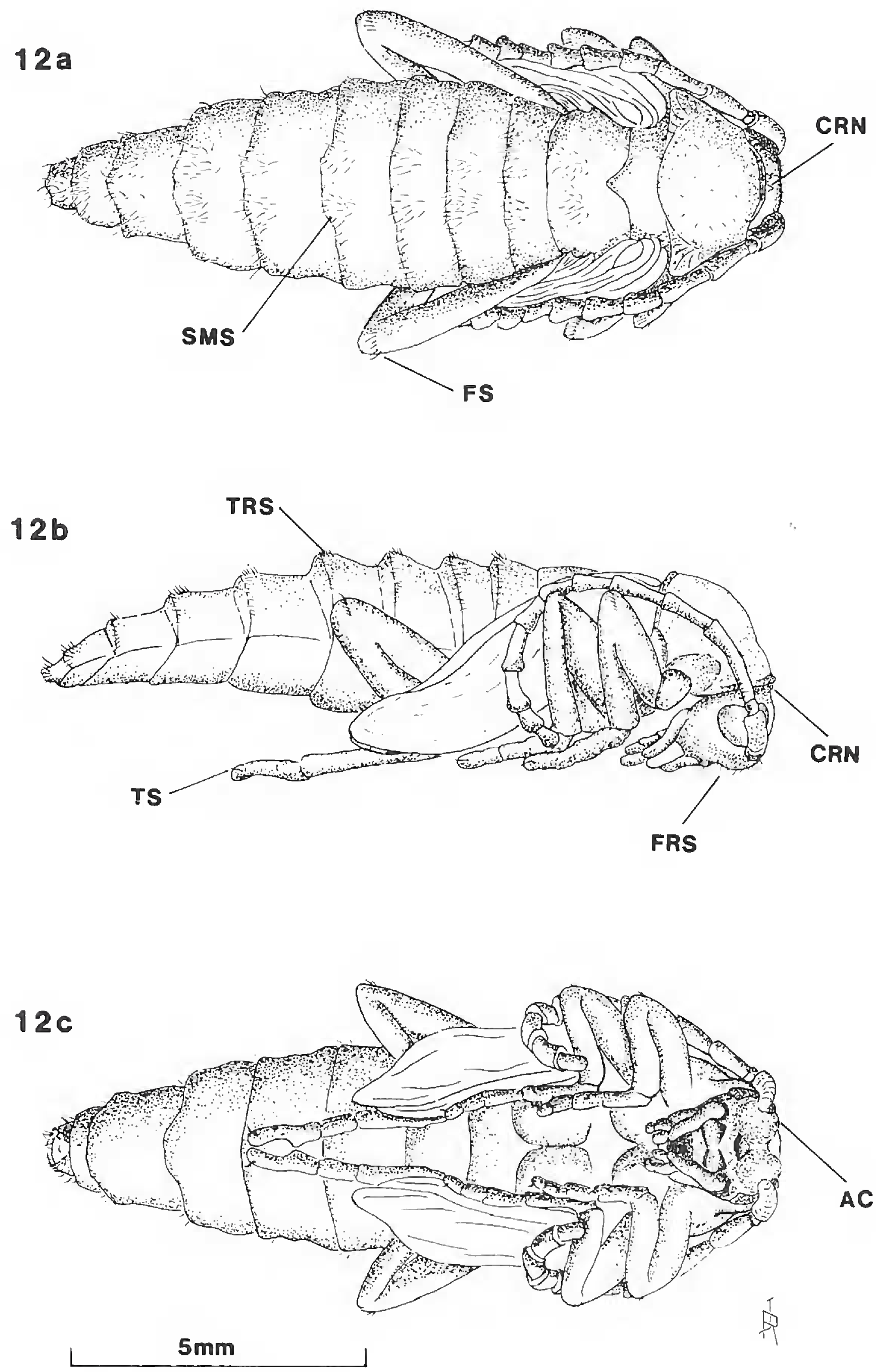


Figure 12. *Typocerus serraticornis* pupa. Figure 12a. Dorsal aspect. CRN, carina; FS, femoral spines; SMS, sub-medial tergal spines. Figure 12b. Lateral aspect. FRS, frontal spines; TS, tarsal spine; TRS, tergal spines. Figure 12c. Ventral aspect. AC, antenniferous callosities.

Biological Observations

The study sites. Six study sites were examined to ascertain what factors were conducive to beetle habitation (Fig. 13). (Soil terminology follows Stewert, et al. 1977; Pleistocene Lake geology follows Snyder, et al. 1964.)

Larkin Dry Lake is an extension of the northeastern corner of Pleistocene Mono Lake. At 2060 m (6,760 ft), it is confined on three sides by steep slopes of volcanic and upper volcanic rocks, mostly basalt, rhyolite and sparse andesite. Coarse sandy alluvial fans blend into playa deposits of soft fine sand. *Artemisia tridentata* Nutt. is the predominant plant with large patches of *Oryzopsis hymenoides* present. Smaller amounts of another grass, *Distichlis spicata* (L.) Greene, are interspersed with *Chrysothamnus nauseosus* (Pall) Britton, *C. viscidiflorus* (Hook) Nutt., *Haplopappus cooperi* (Gray) Hall, *Elymus* sp., and sparse *A. spinescens.* Sparser still, is *Eriogonum umbellatum* Torr. ssp. Many larvae and adults were found here.

Green Spring is located in the Paradise Range of the Toiyabe National Forest at 1829 m (6,000 ft). It is a narrow rocky canyon with steep slopes on either side composed of sedimentary, volcanic and intrusive rocks, with claystone, shale, siltstone and sandstone. The slopes are covered with *Pinus monophylla* Torr. and Frem., and *Juniperus osteosperma* (Torr.) Little. The stoney bottom contains *O. hymenoides, Purshia tridentata* (Pursh.) D.C., *Ephedra viridis* Cov., *Ribes velutinum* Greene, *C. nauseosus, C. viscidiflorus, Artemisia arbuscula* Nutt., *Gutierrezia sarothrae* (Pursh.) Britt. and Rusby, and *Asclepias* sp. Livestock had been feeding on the Indian Ricegrass and the rocky soil was not built up around the culms. There was no evidence of *T. serraticornis* here.

Smith Creek Dry Lake at 1829 m (6,000 ft) is in the middle of a large valley which was itself a much larger Pleistocene lake. The shore line is composed of playa deposits of soft sand with numerous dunes back of the shore, notably on the southeast side. Further back the soil is made up of coarse gravel, small rocks and occasional areas of desert pavement. Patches of *O. hymenoides* are found mixed with *Artemisia tridentata, A. arbuscula, C. viscidiflorus,* infrequent *Purshia tridentata,* and *Selaginella* sp. hugging the sand beneath the sage. Many larvae were found here. Much grazing on Ricegrass was evident.

The Mono Co. sites on Highway 167 are at 1966 m (6,450 ft). The sites are located between the present-day shoreline of Mono Lake and the ancient shoreline on a soft playa deposit. The plant associations are like those of Larkin Dry Lake. Numerous larvae of various instars were found. In early June 1987 at the 4.5 mi site we found teneral adults in pupal cells (Fig. 24) and active males and swollen gravid females were found on the foliage (Fig. 15 and 16). Live gravid females vary in length from 15 to 19 mm (somewhat greater than the dessicated specimens used in the original description).

The Tinemaha Creek site is situated on the alluvial slopes of the east side of the Sierra Nevada at 1219 m (4,000 ft). Because of past volcanism in the Owens Valley much lava and red and black cinder is abundant and "Apache Tears" (obsidian) are frequently found; the sand is coarse. Grazing was evident, possibly by elk which were occasionally seen. No evidence of *T. serraticornis* was found. Higher average temperatures occur in this area compared to the other sites and may well prove to be the modifying factor that precludes the beetle's occurrence in this area (Howden 1963). My findings indicate that the beetle is cold adapted. This may also be true in other areas where Ricegrass is found but the beetle has not been found, as yet.

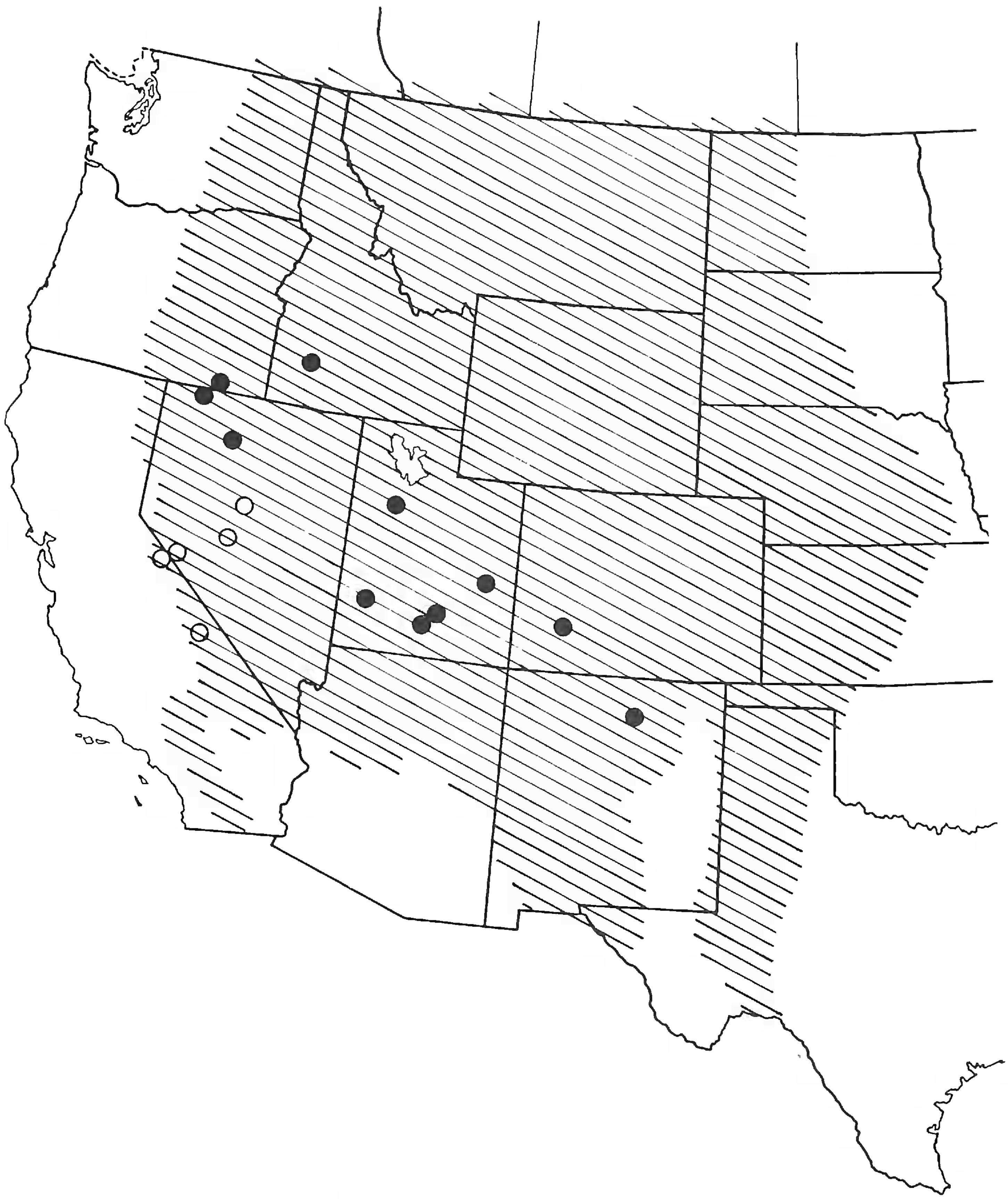
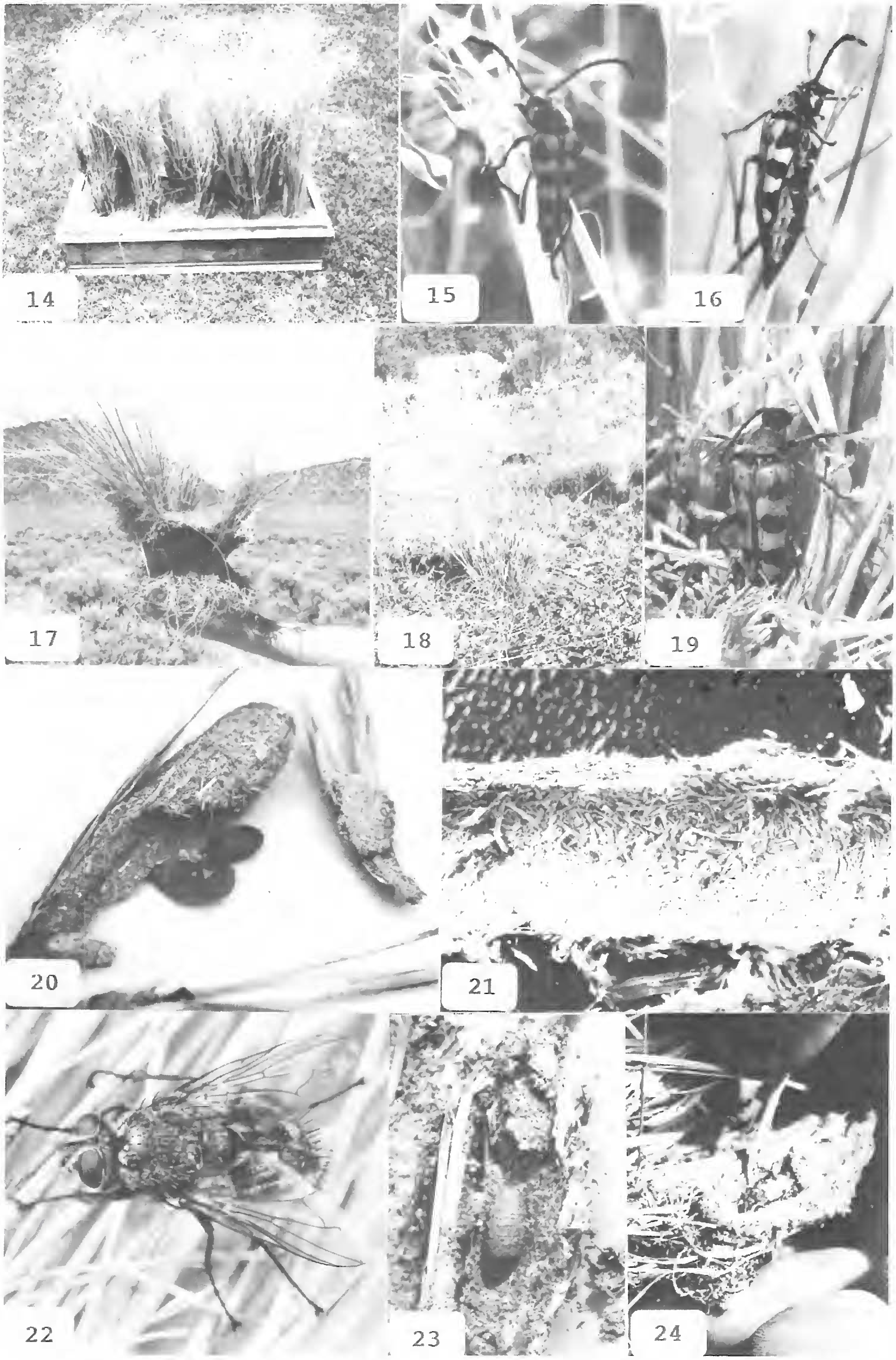


Figure 13. Distribution of *Oryzopsis hymenoides* in the United States (shaded). Recorded collecting sites of *Typocerus serraticornis* (black circles) and the study sites (open circles). Distribution of grass based on standard floras of states shown.

Host Plant. Oryzopsis hymenoides, commonly called Indian Ricegrass, is found on deserts and prairies, in foothills and mountains, from an elevation of 425 to 2745 m (1,400 to 9,000 feet). Its distribution in United States is shown in Fig. 13. It is a densely tufted perennial bunchgrass with leaves or blades mostly at the base. These are involutely wrapped around the stems which are somewhat spreading, forming a thick culm (30 to 70 cm tall) (Crampton, 1974:119). Great numbers of these culms grow tightly together forming a grass clump (Fig. 14). Typical of bunchgrasses, the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center of the clump dies out leaving an outside ring of green and active growth spreading from the previous season's crown. These rings expand over the years, eventually overlapping their neighbors. Abundant seed production assures survival in a given area and its spread to other regions.

It is a native grass, well adapted to arid or semi-arid regions, sometimes abundant on light or sandy soils, especially the shore lines and dunes of dry Pleistocene lakes. In an area of soft sand the lower end of the culm will be covered with 4 to 9 cm (1.2 to 3.5 inches) of sand due to wind action (Fig. 17). Where it grows in harder or rocky soil, the lower portion of the culm is exposed (Fig. 18). The former situation encourages beetle survival because it is here that adults and larvae are readily found. They are not found in the latter.

Mating and oviposition. At collecting sites I observed males and females of *T. serraticornis* flying among the stems and seed heads of the Ricegrass in the typical bouncing manner of lepturines. Females alighting on the stems were rapidly joined by males. Upon assuming the superior position, the male curves the genital segment forward and inserts the phallus. Moving backwards he roughly extracts the female genitalia exposing the last three segments. Returning forward he causes the enjoined genitalia to be at right angles between them; then copulation is completed. Pairs copulated quickly in some instances, the males departing immediately afterwards. In others, coupling lasted for 10 to 15 minutes. A few minutes after separation the female slowly retracts the ovipositor.

Two methods of oviposition were seen: (1) following the male's departure, the female crawls up and down the stem portion of the culm, searching for an oviposition site. While facing upward at this site she chews part way through the stem, causing the part beyond the cut to break, and hang down. The female reverses her position on the stem to a downward facing attitude. She backs up to the cut, extends her ovipositor to it and curls and wipes it across the open break in several directions, depositing a single egg (apparently, eggs not seen) in the break. (2) the female crawls down the stem and culm to a point near the sand and turns about, facing up. She extends her ovipositor and pushes backwards with her forelegs forcing herself into the grass debris and sand to lay the egg (Fig. 19). The female then crawls to another stem or flies to another plant nearby, repeating the process.

Larval feeding. As the larva feeds within the culm, it travels up and down inside the tightly wrapped blades from the base of the culm to a point in the upper end of the narrowing blades. It does not eat through the outer blade and blade sheath. The length of the galleries will generally be below the level of the top of the surrounding

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Figures 14–24. Figure 14. *Oryzopsis hymenoides,* Indian Ricegrass in rearing cage. Figures 15 and 16. *T. serraticornis* male and gravid female on host plant. Figure 17. *O. hymenoides,* showing height to which wind-blown sand rises on the culms. Figure 18. *O. hymenoides* growing on rocky soil and fed on by livestock. Figure 19. Female *T. serraticornis* ovipositing on culm buried in litter. Figure 20. Opened pupal cell with empty skin of beetle larva and puparia of parasitoid fly. Note cell plug at lower left. Figure 21. Compacted and "varnished" wall of pupal cell. Figure 22. Adult parasitoid fly, *Arctophyto borealis.* (Figures 21 and 22 photography by C. L. Hogue). Figure 23. Opened pupal cell containing wasp pupa. Figure 24. *T. serraticornis* male adult in pupal cell.

sand. Returning to the lower end it bores laterally through the culm wall to an adjacent culm, feeding again. In this manner, five to a dozen culms will be fed through, with the galleries being loosely filled with chewed frass. Fecal material generated by the larva was not found.

Pupal cell and pupation. The cell is made by the larva from short fibrous leaf particles or frass produced by chewing adjacent outer blades at the base of several adjoining culms. The frass is forced upward between the culms as a densely packed elongate oval mass. The inside cavity of the cell is shaped by the force of the larval body as it pushes the structure into place (Fig. 20). The structure is fragile at this time, and if the grass culms are severely disturbed it falls apart. A close look at the wall of a finished cell reveals that fine sand grains are present also, and that the frass and sand are cemented together with a film of what is undoubtedly a larval secretion. This cementing process strengthens the wall and waterproofs it to prevent moisture penetration (Fig. 21). This may also shield against attack by fungi. The film is not present during construction, this would hinder the pushing action of the larva, but only after the cell has been occupied. The construction requires eight months to a year. Smaller instar larvae were found starting cells a year prior to pupation. After occupying the cell the larva closes it with a stout frass plug (Fig. 20).

Cells vary 3.2 to 7 cm (1$^1/_4$ to 2$^1/_2$ in.) in length, apparently in respect to the depth of the sand around the plant, the deeper the sand, the longer the cell. Thus the adult, upon emerging through the end of the cell, will crawl through only a minimum of sand to escape.

Enemies: Parasitoid and Livestock Grazing. At the Larkin Dry Lake site and the two sites on Highway 167, 55% of the pupal cells found showed successful emergences as shown by a hole cut in the outer end of the cell and the cell being empty. The other 45% were found closed on the outer end with an emergence hole on the bottom end. Inside the cell was the fed out skin of the larva and the empty puparia of a parasitoid fly (Fig. 20). Some puparia still contained pupae and adult flies have emerged in my rearing cages (The fly's emergence time lags the beetle's five to 10 days.) The fly was identified by B. Cooper as *Arctophyto borealis* (Coq.), a tachinid of the subfamily Dexiinae (Fig. 22). No evidence of the fly was found at the other collecting sites.

At what point in time of the beetle larval development does the adult fly deposit its egg? My findings, based upon the sizes of beetle larvae found, is that the larval stage lasts more than two years, certainly three and possibly four. This is entirely feasible because if one culm of grass dies out, the larva simply bores into an adjacent newly developing culm. Are the flies also as long lived, or are they placed in the feeding gallery or cell at the second or third year?

Indian Ricegrass is very nutritious and it is valuable livestock forage. In many areas of open range country the grass has been seriously overgrazed (Crampton, 1974) (as noted earlier at the 11 mile site on Highway 167). This greatly reduces the stand of grass and allows invasion of hardier plants. The results doubtlessly lower beetle populations (Fig. 18). Recovery is slow from the small amount of seed left behind because of unpredictable moisture and rodent or ant activity.

Associations. At the Larkin Dry Lake and Smith Creek Dry Lake sites some of the empty beetle pupal cells contained the intact "mud" pupal chambers of a predatory wasp and remnants of spider parts (Fig. 23). Adult wasps which emerged have been tentatively identified as *Pisonopsis occidentalis* Williams (Sphecidae) (known spider predators) by R. Snelling. This wasp deposits its eggs and prey in existing cavities and apertures, in this case, the empty beetle pupal cell.

Discussion

Grass-feeding Cerambycids. Grass-feeding in cerambycids is rare. Cerambycid larva are wood borers, feeding in dead, dying, and occasionally, living trees. A few species feed on small woody annual and perennial plants and wild flowers, sometimes in the roots, sometimes in the stems, and larvae of the sub-genus *Homaesthesis* (*Prionus*) feed on roots of sod-forming grasses (Linsley, 1959:103). In instances recorded of grass-feeding, different parts of the plant are used by different species. The literature includes mention only of: "probably" feeding on the roots of Indian Ricegrass by *Prionus emarginatus* (Gwynne and Hostetler, 1978); *Typocerus octonotatus* (mis-identified as *T. sinuatus,* see Linsley and Chemsak, 1976:73) as feeding out the crown of *Andropogon scoparius* Michx., commonly known as Little Blue-stem (Wade, 1922); and *Derobrachus brevicollis* listed as a pest of bahia grass (*Paspalum notatum*), with larvae burrowing in soil and feeding on roots and stolons (Morgan, Tippens and Beckham, 1962). Having collected extensively in Japan, in the Holarctic faunal region, I know of numerous species in several genera of cerambycids that feed on the inside walls of several species of bamboo (Gramineae, as is Indian Ricegrass) (see Kusama, 1973).

Beetle and grass distribution and effects of temperature and moisture. Published collecting records of *T. serraticornis* show it occurs from 762 m (2500 ft) (Strike Lake, Idaho) to 2745 m (9000 ft) (Rico, Colorado). *O. hymenoides* has the same upper limit but occurs as low as 425 m (1400 ft) (Fig. 13). I think future collecting in areas further north of those recorded will find beetles at even lower elevations, because of generally lower temperatures. Based on Howden's postulates I do not think that beetles will occur in the southern extremes of the range of the grass at lower elevations because of the barrier of warmer temperatures. When collecting in December, with mid-day temperatures at 8°C (47°F) ambient, 3.3°C (38°F) on the ground (with patchy snow) and the ground frozen at 11 cm (4.3″) below the surface, I found larvae actively feeding and constructing pupal cells. The night-time low was −7.2°C (19°F). Examination of monthly average temperature/rainfall data for a thirty year period from Fallon, Nevada, at 1250 m (4100 ft) shows a low of −0.4°C (31.2°F) in January to a high of 22.7°C (72.9°F) in July, with a steady change of about 4°C (7.2°F) per month. Rainfall averages 12.7 cm (4.95″) per year, with some rain occurring each month. The direst months are July and August and heaviest rainfall occurs in May, 18.5 mm (.72″ (Rust, 1986). (May of 1987 had a record of 1.71 inches.)

Capture records show the heaviest flights of adults occur the last few days in May and the first week in June. Thus the beetles have emerged, mated, oviposited and larvae are boring into the host following the wettest season (agreeing with Howden, 1963) and 5 to 6 weeks before the warmest weather occurs.

These adaptations to cooler conditions may very well date back to Pleistocene times. Indeed, the beetles and grass may have been more abundant than now, with the current upper elevations of each being the result of increasing warmth and dryness. Pluvial paleoclimates for this region have been estimated as approximately 2.77°C (5°F) cooler than present with an increase in precipitation averaging 68% above the present Great Basin averages (Mifflin and Wheat, 1979).

"Varnish" usage and production. In the section on larval pupal cell construction mention was made of "cementing" of the pupal cell wall. Whether the material can be called "varnish" or "silk" or not, is a matter of conjecture. The material is generated by the larva. Arthropod silks come in many forms, including those described here, and have a number of highly complex formulae; there are several beetle families that are known to produce silk (Rudall and Kenchington, 1977:73–75) (in particular, *definition*). To my best knowledge, this is the first record of a cerambycid doing so, albeit tentative. Some *Moneilema* (Lamiinae) are known to combine secretions with the moisture of decaying cactus to cement the inner walls of their pupal cells (Linsley and Chemsak, after Raske, 1984:20).

The material used on the pupal cell wall is laid down as a thin film with infrequent stranding onto the short fibers forming the wall to act as binder, stiffener and protective sheathing. It shows itself as a somewhat glossy surface on the grass fibers and as a fillet radius at the interface of adjoining fibers. SEM photographs of the cell wall are shown in Fig. 31 and Fig. 32. In the rearing cage in one instance, two larvae in close proximity, having started separate cells merged into one. In the ensuing struggle which occurred between the two, both were liberally covered with the same substance and subsequently died. The same situation was found in the field in June of 1987.

Careful dissection of a freshly killed larva and close examination, including SEM photography, of the head and mouth parts (Figs. 25 and 26); and the anal opening and Malpighian tubules has failed to find any obvious origin for the "varnish." Observation of the living larvae has not disclosed details of the process.

Conclusion

T. serraticornis occupies an ecological niche that ensures success of the species. Its eggs are large to reduce moisture evaporation, and egg-production is minimal.

Its host plant is wide-spread and abundant; adults and larvae are present in large numbers. The beetle is suited to its harsh environment.

Disposition of Materials

Specimens used for this study are deposited at the following institutions: California Academy of Sciences and the Canadian National Collection (tachinids, puparia and beetle larvae skins); Essig Museum of Entomology, Berkeley (eggs, beetle larva, tachinids and puparia); Los Angeles County Museum (slides, vials, eggs, larvae, pupae and adults of beetles, flies and wasps; pupal cells and puparia); and in the collection of the author.

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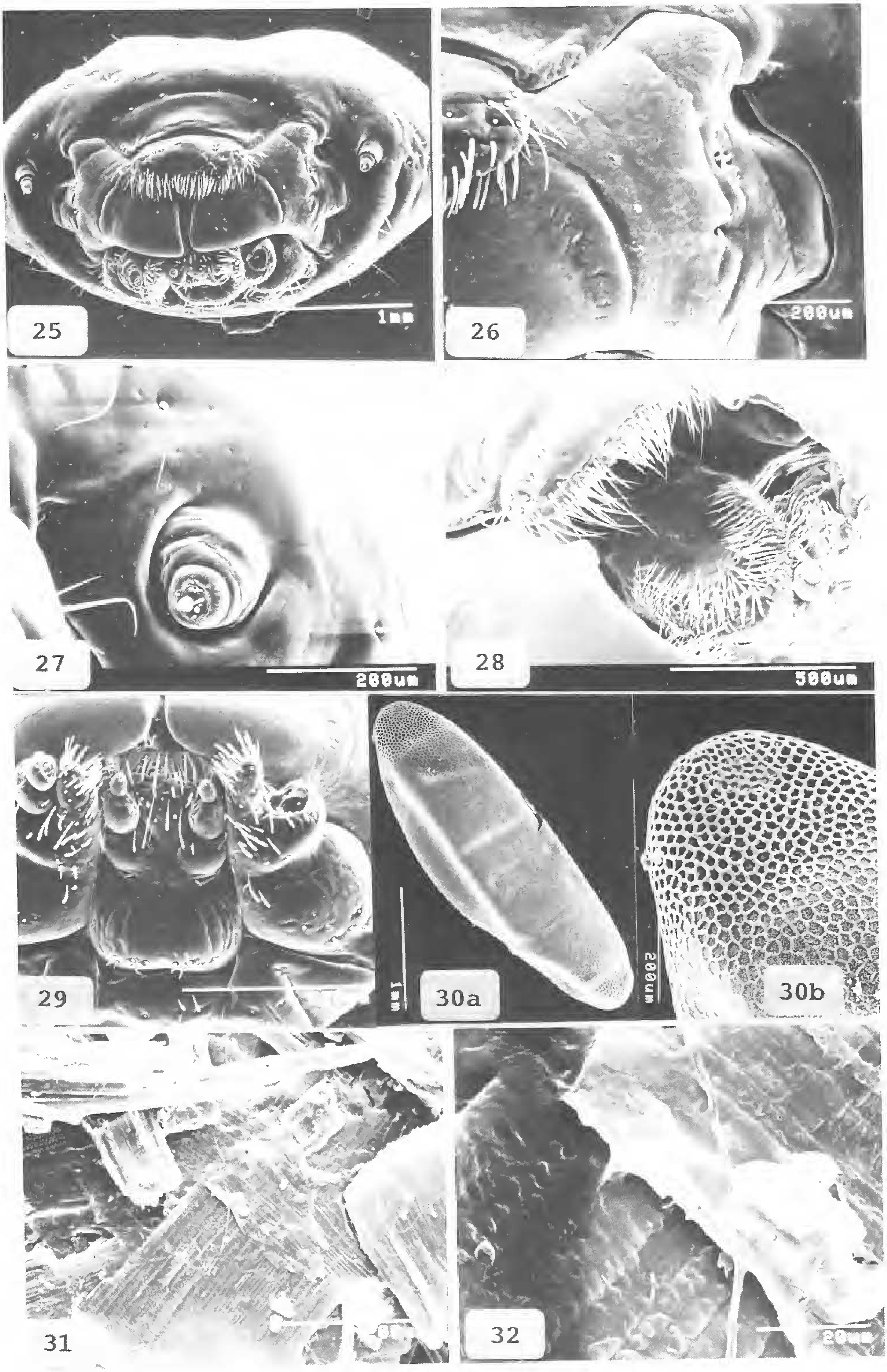
Figures 25–32. SEM photographs of larval structures, egg and "silk" (photography by M. Obika). Figure 25. Upper frontal aspect of larval head. Figure 26. Mandibular attachment, left side. Figure 27. Larval antenna, left side. Figure 28. Looking into mouth. Labrum at upper left. Note discoidal flaking on left mandible, probably from biting on sand grains. Figure 29. Mouth parts, left and right maxilla and labium. Figure 30a. Egg of *T. serraticornis.* Figure 30b. Chorionic detail, showing polygonal shapes. Figure 31. "Silk" film with infrequent strands laid onto the grass fibers in pupal cell wall. Figure 32. 10× magnification of center of prior figure showing strand and film detail at interface of fibers.


25
1mm
26
200um
27
200um
28
500um
29
30a
1mm
200um
30b
31
32
20um

Acknowledgments

I would like to thank the following persons for their untiring help: John A. Chemsak, Essig Museum of Entomology, University of California, Berkeley, for encouraging me to publish my findings; Robert Gustafson and Gary Wallace, Los Angeles County Museum, and David Verity, University of California, Los Angeles, for the many plant identifications; Paul H. Arnaud, Jr., California Academy of Sciences and Bruce C. Cooper, Biosystematics Research Center, Agriculture Canada, Ottawa, for fly identification; Roy Snelling, Los Angeles County Museum, wasp identification; Masataka Obika, Keio University, Yokohama, Japan, for SEM photography; lastly and most importantly, Charles L. Hogue, Los Angeles County Museum for assistance with manuscript preparation and Lowell Ford, Torrance, California, for his endeavors in the field on behalf of this project.

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